



National Institute of Standards & Technology

Certificate

Standard Reference Material[®] 706a

Polystyrene

(Broad Molecular Mass Distribution)

This Standard Reference Material (SRM) is intended primarily for use in calibration and performance evaluation of instruments used to determine the molar mass and molar mass distribution. A unit of SRM 706a consists of approximately 18 g of polystyrene pellets. Each pellet weighs approximately 80 mg.

Certified Value: The certified value for mass-average molar mass (M_w) is based on original results from light scattering and ultracentrifugation measurements on SRM 706 [1,2] and a remeasurement of SRM 706a using light scattering [3]. The certified value represents the highest level of confidence NIST has in its accuracy in that all known or suspected sources of bias have been fully investigated or taken into account.

The certified measurement uncertainty is expressed as a combined expanded uncertainty with a coverage factor $k = 2$, calculated according to the ISO/JCGM and NIST Guides [4]. Type A and Type B contributions to the expanded uncertainty of the certified molar mass include the uncertainties in the light scattering method due to the Rayleigh ratio of the scattering standard, optical alignment, and calibration of the differential refractometer.

Table 1. Certified Value

Property ^(a)	Certified Value and Uncertainty
Mass-Average Molar Mass (M_w)	$2.85 \times 10^5 \text{ g/mol} \pm 0.23 \times 10^5 \text{ g/mol}$

^(a) Expressed as molar mass, previously expressed as molecular weight [5]. The measurand is the mass-average molar mass. Metrological traceability is the SI unit mole.

Expiration of Certification: The certification of **SRM 706a** is valid, within the measurement uncertainty specified, until **20 January 2021**, provided the SRM is handled and stored in accordance with instructions given in this certificate (see “Instructions for Storage”). This certification is nullified if the SRM is damaged, contaminated, or otherwise modified.

Maintenance of SRM Certification: NIST will monitor this SRM over the period of its certification. If substantive technical changes occur that affect the certification before the expiration of this certificate, NIST will notify the purchaser. Registration (see attached sheet or register online) will facilitate notification.

Technical coordination leading to certification of this SRM was provided by B.M. Fanconi of the NIST Polymers Division.

Technical measurement and data interpretation were provided by C.M. Guttman, W.R. Blair, and J.R. Maurey of the NIST Polymers Division.

Support aspects involved in the issuance of this SRM were coordinated through the NIST Office of Reference Materials.

Eric K. Lin, Chief
Polymers Division

Reference Values: A reference value is the best estimate of the true value; however, all known or suspected sources of bias have not been fully investigated. The uncertainties in the reference values for intrinsic viscosity are expressed as the standard deviation of the mean. The reference values for intrinsic viscosity were determined by measurements made on SRM 706 in the solvent benzene at 25 °C and in cyclohexane at 35 °C. The measurand is the intrinsic viscosities listed in Table 2 as determined by the methods indicated in references 1 and 2. Metrological traceability is the SI derived unit for intrinsic viscosity (expressed as milliliters per gram).

Table 2. Reference Values

Property	Reference Value and Standard Deviation of the Mean
Intrinsic Viscosity $[\eta]$, in benzene at 25 °C	93.70 mL/g \pm 0.19 mL/g
Intrinsic Viscosity $[\eta]$, in cyclohexane at 35 °C	39.50 mL/g \pm 0.10 mL/g

Instructions for Storage: The SRM should be stored in the original bottle with the lid tightly closed under normal laboratory conditions.

Homogeneity and Characterization: The homogeneity of SRM 706a was tested using size exclusion chromatography (SEC) analysis of solutions in tetrahydrofuran at 30 °C. The characterization of this polymer is described in reference 3. SRM 706a is a reblending and bottling of the remaining stock of polystyrene used to produce SRM 706.

The SRM 706 polystyrene was originally prepared by thermal polymerization of styrene at 140 °C to 37 % conversion. Ash content is less than 0.001 %. Volatile content is approximately 0.8 %. Determinations of molar mass and intrinsic viscosity are based on the mass of the polystyrene pellets uncorrected for volatiles.

REFERENCES

- [1] SRM 706; *Polystyrene (Broad Molecular Weight Distribution)*; National Bureau of Standards; U.S. Department of Commerce: Washington, DC (1967); available at <https://www-s.nist.gov/srmors/certificates/archive/706.pdf> (accessed Feb 2016).
National Institute of Standards of Technology; U.S. Department of Commerce, NIST: Gaithersburg, MD (13 January 2009); available at https://www-s.nist.gov/srmors/view_detail.cfm?srm=1085B (accessed Feb 2016).
- [2] McIntyre, D.; *Preparation, Purity, and Homogeneity of NBS Standard Samples 705 and 706, Polystyrene*; J. Res. Natl. Bur. Stand., Vol. 71A, No. 1, pp. 43–47 (1967).
- [3] Guttman, C.M.; Blair, W.R.; Maurey, J.R.; *Recertification of SRM 706a, a Polystyrene*; NISTIR 6091; NIST, U.S. Department of Commerce: Gaithersburg, MD (1998).
- [4] JCGM 100:2008; *Evaluation of Measurement Data — Guide to the Expression of Uncertainty in Measurement* (GUM 1995 with Minor Corrections); Joint Committee for Guides in Metrology (2008); available at www.bipm.org/utls/common/documents/jcgm/JCGM_100_2008_E.pdf (accessed Feb 2016); see also Taylor, B.N.; Kuyatt, C.E.; *Guidelines for Evaluating and Expressing the Uncertainty of NIST Measurement Results*; NIST Technical Note 1297; U.S. Government Printing Office: Washington, DC (1994); available at www.nist.gov/pml/pubs/tn1297/index.cfm (accessed Feb 2016).
- [5] Thompson, A.; Taylor, B.N.; *Guide for the Use of the International System of Units (SI)*; NIST Special Publication 811; U.S. Government Printing Office: Washington, DC (2008); available at www.nist.gov/pml/pubs/index.cfm/ (accessed Feb 2016).

Certificate Revision History: 09 February 2016 (Change of expiration date; editorial changes); 29 August 2011 (Extension of the certification period; editorial changes); 17 November 2003 (This revision reflects a change in the certification expiration date); 02 September 1998 (Original certificate date).

Users of this SRM should ensure that the Certificate in their possession is current. This can be accomplished by contacting the SRM Program: telephone (301) 975-2200; fax (301) 926-4751; e-mail srminfo@nist.gov; or via the Internet <http://www.nist.gov/srm>.